# DIURNAL AND NOCTURNAL MORTALITY OF ANT-TENDED TREEHOPPERS (HEMIPTERA: EURYMELIDAE) ON A TEMPERATE-ZONE EUCALYPT

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## Abstract
Excluding a tending *Iridomyrmex* sp. from experimental populations of *Eurymeloides musgravei* Evans on *Eucalyptus melliodora* A. Cunn. ex Schauer in Canberra, ACT increased the overall treehopper mortality rate by 70% relative to controls. This overall increase was due entirely to an increase in the diurnal mortality rate, by a factor of 13 times; the nocturnal rate did not change significantly.

## Introduction and Methods
Many Auchenorrhyncha are tended by ants which reduce their mortality rates (Buckley 1987; Cushman and Addicott 1989). Here the effects of this ant defence by day and night respectively are compared for a eurymelid treehopper, *Eurymeloides musgravei*, on a sterile planted sapling of *Eucalyptus melliodora*, 3 m high and 3 m in diameter, growing near the edge of native mixed eucalyptus woodland in the Black Mountain Reserve, Canberra. Evans (1966, p. 67) also recorded *E. musgravei* on Black Mountain, and Evans (1931) recorded *Eurymela* spp. attended by 3 *Iridomyrmex* spp. in the Canberra area. Evans (1931) also described the general morphology and behaviour of eurymelids as exemplified by *Eurymela distincta* in what is now the ACT, recording eggs parasitised by chalcid wasps, others eaten by chloropid flies, and nymphs parasitised by lepidopteran larvae, probably epipyropid moths. He recorded *Eucalyptus melliodora* as a eurymelid host plant, but only for *Eurymelops rubrovittata*.

The experimental population occupied a single host plant and was tended by ants from a single nest. Using the sticky barrier resin Tanglefoot®, ants were excluded from 6 branches. Ants and treehopper instars were counted at dawn and dusk for 6 days, on these and on 6 control branches. New cohorts of first-instar eurymelids hatching during the experimental period were excluded from the counts.

To test the effects of ant attendance on eurymelid mortality rates, I analysed these counts as follows.

1. Aggregated counts for all instars to give total numbers of individual eurymelids in each subpopulation at each count.

2. Subtracted successive counts to determine the numbers of eurymelids which disappeared from each of the 12 subpopulations during each of the 6 nights and 6 days.

3. Aggregated the 6 nights and the 6 days respectively to allocate each of the individual eurymelids to one of three categories, namely those which

disappeared during the night, those which disappeared during the day, and those which remained until the end of the experimental period.

Eurymelids which disappeared between counts were presumed to have died, and death and disappearance are treated interchangeably henceforth. The reasons for this assumption are as follows.

1.      Most of the individuals were late-instar nymphs. Even under severe provocation, these were never observed to jump, and adults only rarely; instead, they dodged quickly behind twigs.

2.      I trimmed leaves so that the 12 branches were isolated from the rest of the tree except via their main stems. I kept the tree under observation at intervals during both days and nights and never saw eurymelids on these main stems, nor were any trapped in the tanglefoot® collars; they remained on the distal twigs.

Changes in eurymelid numbers in each of the 12 subpopulations may therefore be considered independent. Numbers of ants on the control branches may also be considered independent since relatively few of the total number of workers in the colony were present on the tree at any given time; the number of ants on any one branch was not limited by the number on any other branch.

The absolute numbers of eurymelids disappearing between counts on each branch cannot be treated directly as experimental replicates, however, since they may depend on the initial sizes of the subpopulations concerned. There are two ways to overcome this difficulty. The first is to aggregate the 6 experimental and 6 control subpopulations respectively and examine the effects of ant attendance using contingency tables. The alternative is to convert absolute numbers of individuals which disappeared by day and night respectively into proportional mortality rates, individuals per individual per day, and to treat these rates as independent replicates. Both these approaches are used here.

### Results
The fates of individual eurymelids in each subpopulation are summarised in Table 1. These results, aggregated over subpopulations, are shown in Table 2 as a contingency table. Average aggregate proportional mortality rates (AAPMR) may be expressed as individuals per individual per day, i.e. day$^{-1}$. These AAPMR's are not true daily mortality rates, but one sixth of the mortality rates over a period of 6 days. For comparing relative rates, however, this does not matter. The statistical significance of differences in mortality rates are tested using actual numbers of individuals, not AAPMR's. In these units, the AAPMR was 0.0645/day (67/186/6) for ant-tended eurymelids, and 0.110/day for untended eurymelids: 70% higher. Aggregating the first two columns of Table 2 and comparing with the third shows that this effect is significant at p < 0.001 ($\chi^2 = 28.3$). The diurnal

**Table 1.**   Fate of individuals in 6 tended and 6 untended eurymelid subpopulations.

| | Ant-tended (control) | | | Untended (experimental) | | | |
|---|---|---|---|---|---|---|---|
| | Initial Number | Died by day | Died at night | Lived to end | Initial number | Died by day | Died at night | Lived to end |
| | 28 | 0 | 7 | 21 | 15 | 4 | 6 | 5 |
| | 16 | 0 | 10 | 6 | 16 | 5 | 3 | 8 |
| | 23 | 0 | 5 | 18 | 20 | 7 | 12 | 1 |
| | 46 | 2 | 13 | 31 | 25 | 7 | 9 | 9 |
| | 35 | 1 | 16 | 18 | 76 | 25 | 20 | 31 |
| | 38 | 2 | 16 | 20 | 42 | 13 | 17 | 12 |
| Total | 186 | 5 | 67 | 114 | 194 | 61 | 67 | 66 |

mortality rate of ant-tended eurymelids is 0.004/day, as compared to 0.052/day for untended individuals.   Comparing the first two columns of Table 2 shows that this is also significant at $p < 0.001$ ($\chi^2 = 34.5$).   Aggregate proportional nocturnal mortality rates, however, were 0.060/day and 0.058/day for tended and untended eurymelids respectively; not significantly different.   Proportional disappearance rates are summarised in Table 3.   Time of day, ant-attendance and their interaction all had significant effects on mortality rates (Two-way ANOVA; $F = 22.5, 10.3, 11.1$; $p < 0.01$ in each case).   Duncan's range test shows that this heterogeneity is due to the low diurnal mortality rate for ant-tended populations; this is significantly ($p < 0.01$) lower than the other three rates, which do not differ significantly from each other.

**Table 2.**   Differential effects of tending by ants on diurnal and nocturnal disappearance of eurymelids: aggregate of subpopulations.

| | Disappeared During night | Disappeared During day | Still present at end | Totals |
|---|---|---|---|---|
| With ants | 67 | 5 | 114 | 186 |
| No ants | 67 | 61 | 66 | 194 |
| Totals | 134 | 66 | 180 | 380 |

**Discussion**

I did not attempt to determine the physical causes of eurymelid mortality. Spiders and predatory bugs were abundant on the host tree and I observed both capturing and consuming eurymelids.   Some of the eurymelids from which ants were excluded turned from their normal black to a yellowish colour before disappearing from the branch, but this could have been due to retention of honeydew rather than parasitisation.   None were coated with honeydew or attacked by fungi, but the experimental period was probably too short for any such effect to have become apparent.

Diurnal and nocturnal mortality rates have previously been compared for only

**Table 3.** Proportional disappearance rates for 6 tended and 6 untended eurymelid subpopulations. Average Aggregate Proportional Mortality Rates.

| Ant-tended (control) | | | Untended (experimental) | | |
|---|---|---|---|---|---|
| day | night | total | day | night | total |
| 0.000 | 0.042 | 0.042 | 0.044 | 0.067 | 0.110 |
| 0.000 | 0.104 | 0.104 | 0.052 | 0.031 | 0.083 |
| 0.000 | 0.036 | 0.036 | 0.058 | 0.100 | 0.158 |
| 0.007 | 0.047 | 0.052 | 0.047 | 0.060 | 0.107 |
| 0.005 | 0.076 | 0.081 | 0.055 | 0.044 | 0.099 |
| 0.009 | 0.070 | 0.079 | 0.052 | 0.067 | 0.119 |

one other ant-tended auchenorrhynchan, a tropical eurymelid (Buckley 1990). In that case, the nocturnal mortality rate for untended individuals was significantly higher than the other three rates. In this case, the diurnal mortality rate for ant-tended species is significantly lower than the other three rates. In both cases, the ant defence was more effective by day: but nocturnal enemies were more significant in the tropics, diurnal ones in the temperate zone. Data from other sites and species will be needed to determine whether this is representative of a general pattern.

## Acknowledgments

## References

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